tions, produce a known quantity of electricity, or which would charge a condenser of one microfarad capacity to a given potential. Knowledge as to the power of a galvanic battery was much more definite. Everything in that respect could be stated with exactitude. If knowledge of the practical uses of electrical machines were comparable with that in respect to the galvanic battery, knowledge as to the efficiency of the former would soon be equally definite. The necessity of proper standards based on numerical data was understood in more than one branch of physics; but the present remarks were directed only to electricity, which had in recent years undergone almost a complete transformation. After describing the principles upon which a system of electrical measurement should be founded, the steps taken by Ohm, Weber, Oersted, and others, in arriving at definite laws, were related and tabulated for comparison. Weber's system had been extended by Sir W. Thomson, and the practical applications of electricity in its early days produced the necessity of being able to express results upon a coherent system of standard units. For that purpose the committee of the British Association on electrical standards was appointed, and the B. A. unit resulted. The data upon which that unit was founded had subsequently been verified, and at the present time a redetermination of its accuracy was about to take place. The absence of any standard resistance coils was pointed out, and the suggestion made that it would reflect credit on the Society if it at once set to work with the view of establishing a definite standard resistance, with which instruments used for every-day practical purposes could be occasionally verified and adjusted. A paper on "Some Experiments on Induction with the Telephone," by Mr. A. W. Heaviside, was then read. In the discussion which followed, Prof. Hughes, Mr. Stroh, Prof. Ayrton, and others took part.

FURTHER NOTES ON THE BRAIN OF THE IGUANA AND OTHER SAUROPSIDÆ.

By Edward C. Spitzka, M. D.

I would add to the observations published in No. 7, Vol. I. of Science, relating to the brain of the Iguana, the following:

1st. The ganglionic intumescence upon the inner edge of the cerebral hemisphere, which I supposed to represent the homologue of the molecular basis of the Fascia dentata of Tarini in the mammalia, is more voluminous in the middle of the hemispheric length, than in the posterior third. The homologization of the entire inner wall of the hemisphere with the *Cornu Ammonis* of mammals gains strength from the fact that in the Opossum the Cornu Ammonis extends almost along the whole inner hemispheric wall, and is but slightly folded as compared with that of the Rodentia. That the elevation which I supposed to correspond to the *fascia dentata* and *tæniola cinerea*, might be interpreted as one of the thalamic tubercles, which I considered an open question at the time of my writing the first commmunication, and which I now hold to be disposed of definitely as well as the other supposition.

2nd. There is a molecular accumulation at the base of the cerebral hemisphere, in the common basilar gray, and beneath the elevation of the *corpus striatum*, which may correspond to the lenticular nucleus.

3rd. At and above the level of the emerging third pair of nerves, there is a beautiful nucleus of large multipolar cells, resembling the cells of the auditory nucleus (that is of the large celled division of that nucleus) in contour and in dimensions. This cell group in its situation corresponds to the *nucleus tegmenti* of mammals. I would here note that throughout the animal range, the cells of the *nucleus tegmenti* and the special division of the auditory nucleus referred to seem to keep step in development. This fact would add another link to the chain of evidence attempted by Meynert, who surmised that an auditory tract passed through the cerebellum to the *brachium conjunctivum*, (and therefore through this cell group) on its way to higher projecting fields.

4th. The so-called *nucleus dentatus* of the cerebellum, which should be termed simply *nucleus cerebelli*, since it is not dentated even in all the mammalia, is clearly present in the cerebellum of the Iguana. It can be found at the junction of the cerebellar peduncles with the main cerebellar mass, and consists of well marked cells of moderate dimensions.

5th. The "fasciculus from the habenulæ to the tegmentum" so-called by Meynert, but which Gudden and his pupils correctly state to run from the habenulæ to the *ganglion interpedunculare*, has not been yet identified in animals lower in rank than the mammalia. I find it well-developed occupying exactly the same relations and presenting the same histological peculiarities as with mammals in the Iguana.

6th. The fourth pair does not reach the valve of Vieussens in levels lower than those in which the root has its origin, as in the turtle (*Nanemys guttatus, Chelydra*) and the mammalia, but distinctly arises in the same level in which it reaches the valvule where it decussates. The nerve itself, however, emerges in levels superior to the latter.

7th. While the cells of the oculomotoriotrochlearis nucleus, and those of part of the auditory origin are of large dimensions, those of the abducens, facial, and motor-trigeminal origin are remarkably small. The reduction in size of the cells is as might be inferred accompanied by a reduction in size of their nuclei. This fact suffices to dispose of the recently advanced claims, that motor cells have larger nuclei than sensory ones. The reduction in size of these motor groups and their presenting such a contrast to the great development of the cells in other motor groups in the Iguana, has to my mind much of the enigmatical. The largest cells in the nervous system of the Iguana, are the multipolar cells of the reticular field, (my *ganglion reticulare* in mammals) those of the auditory origin and *nucleus tegmenti* are of the same or nearly the same dimensions.

8th. The mesencephalic nucleus of the fifth pair is represented as in other reptiles by round cells, sunk in the niche between the two optic lobes; they are not spread out on the contour of the central tubular grey, as in mammals, but concentrated more at the median line. Some of the cells can be identified beneath the inter-optic lobes.

9th. The cells of the substantia ferruginea of man are represented by a group of numerous small ganglionic bodies, whose connection with the fifth nerve is clearer than in the mammalia.

10th. The auditory nerve fibres send a powerful strand which decussates with its fellow in the raphe. In its course each strand traverses or circumscribes the posterior longitudinal fasciculus. This same strand is found in the mammalia, but in the latter it is deeply seated; in the Iguana it is more superficial, and the erroneous inference might be drawn that this strand in the reptile is equivalent to the *striæ acustici* of mammals. The latter are however, absent in reptiles, and although in some species visible eminences are formed at the floor of the fourth ventricle, crossing at right angles the longitudinal eminences of the posterior longitudinal fasciculi; these are the homologues of the more anterior and concealed part of the auditory decussation of mammals.

11th. In no reptile have the nuclei of the columns of Goll and Burdach been identified. In the Iguana I can readily identify them, although much smaller than the corresponding nuclei of the mammalia. Their demarcation is, however, distinct.

12th. In the Iguana as in the turtle there is an accumulation of numerous multipolar cells at the raphe in the

level of the junction of the cord and oblongata. In addition a group of remarkably attenuated cells is found at the origin of the spinal accessory. These cells are so much elongated and their protoplasm has been so much narrowed that but for the discovery of a nucleus in one or the other cell, one might consider them a bundle of axis cylinders. These are better developed in turtles than in the Iguana, and better in fresh water species than in the *Thallassochelys mydas*. In no turtle have I found the cells of the raphe very large, but in the Iguana I have discovered a few very large cells in the same level and location as those first described by Dr. J. J. Mason for the Alligator.

13th. In my first paper I indicated the existence in the Iguana of a hitherto undiscovered pair of lobes or tubercles between the optic and post optic lobes. I have also indicated their homology with a concealed pair in the turtle and alligator. At the time I did not describe the topographical relations minutely. Normally—if I may use the expression—as in the turtle and alligator, the newly discovered ganglia lie at the margin of the central tubular gray of the mesencephalon, in the anterior part of the *corpora quadrigemina*. As we go more posteriorly they are found to extend more dorsally, until in the turtle, for example, they nearly touch in the median line just at the posterior fifth of the optic lobes, where they cease. In the Iguana the relations are the same, but instead of terminating before the posterior margin of the optic lobes, they extend further backwards and prominate at the surface of the brain, as two sharply marked buttons. Their structure is the same in all reptiles so far examined, a molecular basis and small roundish cellular elements. In anterior levels nerve fibres can be seen entering them in strands, from the arched fibre mass which is found beneath the deep gray layer of the optic lobes. Although all surmises as to the function of the inter-optic lobes are as yet strictly hypothetical; yet from the fact that they are directly connected with the central tubular gray, and are under the fascicular subjection of the optic lobes, and that they are well developed in reptiles, and poorly, if at all, developed in mammals, one might suspect them to have some relation to the innovation of the Harderian gland, just as the mesencaphalic nucleus of the fifth pair may be looked upon as the probable centre for the innervation of the lachrymal gland proper.

RECENT PROGRESS OF SCIENCE.

Rev. Samuel Fleming, LL.D., Ph. D.

The progress of science within our own times has been wonderful. Prof. Helmholtz uses the following language: "The contemplation of the astounding activity in all branches of science may well make us stand aghast at the audacity of man, and exclaim with the chorus in the Antigone: Who can survey the whole field of knowlege? Who can grasp the clues, and then thread the labyrinth?" Every department of science has been vastly extended, and every votary of science stimulated to untiring efforts to survey this field, not only, but to enter the secret chambers of knowledge to find the treasures concealed from the human mind, until modern discoveries, modern analysis, and modern invention have combined to make those hitherto hidden facts of science known, and available for practical benefits to human society.

The exact science, Mathematics, has found ample room for the application of its principles and methods of determining the content of all material existences and relations. The sublime science, Astronomy, has reveled in its excursions into illimitable space, adding new triumphs, discovering new facts pertaining to the constitution of the stellar universe, and the relations of the celestial masses, measuring, by the agency of light, the immense distances, magnitudes and motions of the tiny objects which the natural eyes behold in the expanse above, and in former times regarded as "fixed stars." The profound science, Geology, has carried us back into the illimitable depths of past duration, to contemplate the usually slow process by which the earth has been changing from its primordeal, nebulous condition, to that in which it has become fitted for living and rational beings, adding new testimonies of the rocks to the truth of Scripture, expressed by the significant language: "Of old hast thou laid the foundations of the earth." The widely related, efficient science, included in the scope of terrestrial Mechanics, has found abundant use for its forces, and the practical application of its dynamics, in the constantly increasing demands of human society. The splendid and delicate science, Chemistry, has exulted in its new and valuable discoveries in the realm of atoms and molecules, verifying the atomic theory, and adding new evidences that many of the supposed elements of matter are really compounds, and must yield to the searching analysis which finds them to be but molecules composed of two or more atoms. The vast and richly diversified science, Biology, has yielded its living evidences of the progressing series of organic natures, and of the vast scope of its history, extending its relations to ancestries, the periods of whose origin belong to the immeasurable epochs of palæontological history, The crowning, all-conserving science, Anthropology, has added new evidences of its superiority in importance, as it stands highest in the scale of associated sciences; and while it has maintained this highest rank by maintaining the honor of its subject-matter, its votaries have found its latest and greatest achievement in the evidences of a formal psychical constitution as the basis of mental action.

It is not the aim of the writer to pursue the history of the development of the sciences, exhaustively, but to indicate some of the lines of progress.

The brilliant discoveries in Astronomy, within the past few years, have added largely to the wealth of this noble science, fascinating the student, and inspiring to new achievements. Previous to the present century, the solar system included seven primary planets as having at that time been discovered. In the year 1800 a new planet was discovered, and designated an asteroid, or small star,—but it is more properly called a planetoid, or small planet. The name by which this is known is Ceres, after the reputed originator, or god, of corn. It was an event of so great interest to astronomers that it was announced with much eclat that "The long-expected planet between Mars and Jupiter had been discovered." Soon after, three more were observed. Since that time, by means of the greatly increased power of telescopes, more than two hundred have been added by discovery, all being very small. Many others will be found. The problem still to be determined has been, whether these planetoids are "fragments of a broken world," as formerly supposed, or separate condensations from cosmic matter, instead of forming one large body, as in the case of other primary planets. It is not probable, however, that a cosmic mass exploded at any one period, producing such fragments in such positions in their orbits as they maintain, nor that such original mass was so dissipated by the action of a propulsive or radiate force at one time, as to resume its original nebulous state. The second hypothesis is the more probable, viz.: of separate condensations from original nebulosity.

Neptune, one of the largest planets, and nearly twice the distance of Herschel from the sun, was discovered in 1846 by M. Challis, of Paris, and its elements and orbit determined by Le Verrier. The discovery of this planet furnished a satisfactory explanation of the aberrations of the planet Herschel, caused by the approximations of Neptune, though distant, at its nearest point, more than a billion and a half miles. This increase of the number of the solar family furnished an additional illustration, on a grand scale, of the laws of universal gravitation and